Number/ Level	Requirement Title	Requirement Level	Requirement
01	**Spacecraft**	System	The Chemistry MedSat spacecraft(s) shall be designed for a minimum lifetime of 6 years in orbit, and shall provide s/c bus services to integrally mounted science instrument(s) for observation of atmospheric chemical species [illegible]
01.01	**Power**	Subsystem	The spacecraft power subsystem shall convert solar energy to electrical power, and make it available to the electrical subsystem for power switching and distribution
01.01.00.01	**Energy Generation/ Storage**	Functional Category	The power subsystem shall be designed to perform nominal science operation at all times, including eclipse, yaw maneuvers, orbit reboost, etc.
01.01.00.01.01	Load Requirement	Functional Requirement	The power subsystem shall support observatory nominal and peak loads during the projected mission life
01.01.00.01.01.01		*Performance Requirement*	*The power subsystem shall be capable of providing the TES instrument 344 watts average and 363 watts peak*
01.01.00.01.01.02		*Performance Requirement*	*The power subsystem shall be capable of providing the HIRDLS instrument 195 watts average and 288 watts peak*
01.01.00.01.01.03		*Performance Requirement*	*The power subsystem shall be capable of providing the MLS instrument 488 watts average and TBD watts peak*
01.01.00.01.01.04		*Performance Requirement*	*The power subsystem shall be capable of providing the ODUS instrument 63 watts average and 88 watts peak*
01.01.00.01.01.05		*Performance Requirement*	*The power subsystem shall provide 28 Vdc +7, -4 Vdc power for distribution to the instruments*
01.01.00.01.02	Energy Storage	Functional Requirement	The spacecraft shall provide an energy storage capability, implemented through an energy storage system
01.01.00.01.02.01		*Performance Requirement*	*The energy storage system shall provide sufficient capacity during launch, deployment, and sun acquisition (TBD hours)*
01.01.00.01.03	Solar Array	Functional Requirement	The solar array shall provide adequate electrical power to support the normal science mission through the end of the projected mission life (six years)
01.01.00.02	**Power and Signal Distribution**	Functional Category	The power subsystem elements shall accept control commands and provide sufficient status data to safely initialize, maintain, and provide circuit protection for the spacecraft power in all phases of the mission
01.01.00.02.01	Power Distribution	Functional Requirement	The power subsystem shall supply compatible power bus interface(s) for the existing instruments
01.01.00.02.02	Control Command	Functional Requirement	The power subsystem shall accept ground commands and provide telemetry in order to control typically autonomous spacecraft power functions

Number/ Level	Requirement Title	Requirement Level	Requirement
01.01.00.02.03	GSE Power Distribution	Functional Requirement	The spacecraft shall accommodate an external source of power to the observatory during integration and test activities

Number/ Level	Requirement Title	Requirement Level	Requirement
01.02	**Electrical**	Subsystem	The electrical subsystem shall provide electrical services to the spacecraft components and instruments
01.02.00.01	**Power Distribution**	Functional Category	The electrical subsystem shall distribute compatible power to all observatory components
01.02.00.01.01	Power Characteristics	Functional Requirement	The characteristics of distributed power shall not degrade or cause observatory components to malfunction
01.02.00.01.01.01		*Performance Requirement*	*The spacecraft shall meet all instrument electrical power interface requirements specified in the GIRD*
01.02.00.01.01.02		*Performance Requirement*	*Power bus noise and ripple at the power subsystem output shall be limited to 0.5 Volts peak-to-peak over the frequency range of 1 Hz to 10 MHz, under any load condition. Over 10 MHz, ripple shall be limited*
01.02.00.01.01.03		*Performance Requirement*	*The input ripple on the power bus at the instrument input shall be limited to less than 5% peak-to-peak of the line voltage over all frequency ranges from 1 Hz to 10Mhz*
01.02.00.01.01.04		*Performance Requirement*	*During all operating modes, the power subsystem shall not produce common mode voltage on its outputs exceeding 100mV peak-to-peak, in the shall be made both between power (+28) and chassis, and between power return and the chassis*
01.02.00.01.02	Circuit Protection	Functional Requirement	The electrical subsystem shall provide undervoltage, overvoltage, load shedding, and current-limiting capabilities
01.02.00.01.03	Redundancy	Functional Requirement	Input power to each user instrument shall be provided by redundant power sources
01.02.00.01.03.01		*Performance Requirement*	*The spacecraft shall be capable of operating the spacecraft subsystems and all instruments in their normal modes simultaneously and continuously*
01.02.00.01.04	Instrument Power Interface	Functional Requirement	The spacecraft shall provide a compatible power interface to resident instrument(s) in accordance with the requirements specified in the GIRD
01.02.00.02	**Power Switching/ Circuit Protectio**	Functional Category	The electrical subsystem shall provide the capability of power on/off switching and circuit protection
01.02.00.02.01	Power Switching	Functional Requirement	The spacecraft shall be capable of switching power to each of the instruments
01.02.01.02.01	Power Switching (Launch Mode)	Functional Requirement (Launch Mode)	The spacecraft shall be capable of supplying power to the instruments during the launch phase (minimum of survival power)
01.02.00.02.02	Bus Circuit Protection	Functional Requirement	Circuit protection of primary power shall be accomplished in the power switching/distribution units
01.02.00.03	**Pulse Commands**	Functional Category	The electrical subsystem shall provide the necessary pulse commands for all components that require pulse commands (e.g., pyro activation)

Number/ Level	Requirement Title	Requirement Level	Requirement
01.02.00.04	**Control Processing**	Functional Category	The electrical subsystem shall provide command interfaces for spacecraft and instrument components that can not communicate over the data bus
01.02.00.05	**Signal Processing**	Functional Category	The electrical subsystem shall provide the capability to monitor spacecraft and instrument vital signs such as voltages, status, switch closure, temperature, serial digital and other miscellaneous data points
01.02.00.06	**Data Bus Control**	Functional Category	The power switching/distribution units shall provide a data interface and perform launch sequencing for the observatory
01.02.00.07	**Temperature Sensor Monitori**	Functional Category	The electrical subsystem shall provide the capability for monitoring temperature sensors
01.02.00.08	**Electrical Compatibility**	Functional Category	The spacecraft shall be compatible with the EMI/EMC and magnetic requirements stated in the GIRD
01.02.00.09	**Grounding**	Functional Category	The spacecraft shall utilize a multi-point grounding scheme
01.02.00.09.01	Chassis Grounding	Functional Requirement	Secondary power returns shall be tied to the chassis and isolated from primary power
01.02.00.09.02	Bonding Requirements	Functional Requirement	All subsystem and instrument boxes containing electronics shall have cases bonded to spacecraft structure
01.02.00.09.03	Thermal Blanket Grounding	Functional Requirement	All metalized and conductive surfaces of Multilayer Insulation shall be electrically grounded to prevent electro-static build-up
01.02.00.09.04	Solar Array Grounding	Functional Requirement	Solar Array panels and substrates shall be electrically grounded to the structure
01.02.00.09.05	Antenna Grounding	Functional Requirement	The antenna design shall provide a means of allowing static discharge
01.02.00.10	**Harness**	Functional Category	The electrical subsystem shall provide the harness for spacecraft electronics and instruments

Number/ Level	Requirement Title	Requirement Level	Requirement
01.03	**C&DH**	Subsystem	The C&DH subsystem shall provide data processing, data storage, command and control, telemetry, and timing for the observatory
01.03.00.01	**Ground Command Processing**	Functional Category	The C&DH shall process uplink commands from the transponder
01.03.00.01.01	CCSDS Ground Command Implementation	Functional Requirement	The C&DH shall support the implementation of The Command Operations Procedure-1 (COP-1) as specified in "CCSDS Recommendations for Telecommand, Part 2 Data Routing Service" and in "Recommendations for SpaceData System Standards, Telecommand, Part 2.1"
01.03.00.01.01.01		*Performance Requirement*	*The spacecraft shall verify receipt of commands and perform error detection, rejecting each telecommand (TC) frame that contains error(s), and report rejections to the ground via telemetry*
01.03.00.01.01.02		*Performance Requirement*	*Spacecraft command and storage shall be capable of supporting absolute time commands and relative time sequences*
01.03.00.01.01.03		*Performance Requirement*	*Absolute time commands shall be sent from the on-board spacecraft processor to other components at prespecified times with a resolution of 1.0 seconds*
01.03.00.01.01.04		*Performance Requirement*	*Relative time sequences shall be sequences of commands which can be sent from the on-board processor following a predefined sequence*
01.03.00.01.01.05		*Performance Requirement*	*The spacecraft shall be capable of supporting all routine normal operations with not more than a single 20 minute data (including commands) uplink session every 24 hours at a rate of 1 kbps*
01.03.00.01.02	Special Commands	Functional Requirement	Special commands shall be implemented to allow the reset or reconfiguration of the spacecraft independent of the flight software and data bus in the event of
01.03.00.01.02.01		*Performance Requirement*	*The spacecraft design shall be such that all onboard automatic functions (or sequences) can be over-ridden by ground commands*
01.03.00.02	**Telemetry Processing (downlin**	Functional Category	The telemetry data collected from the observatory components via the data bus shall be formatted and transmitted to the data storage unit and/or transponders
01.03.00.02.01	CCSDS Requirements for Telemetry	Functional Requirement	The telemetry data shall be packetized in accordance with the CCSDS standard for ground transmission
01.03.00.02.01.01		*Performance Requirement*	*All telemetry(S- and X-band) shall be formatted in accordance with the recommendations in "CCSDS Recommendation for Advanced Orbiting Systems, Networks and Datalinks: Architectural Specification" for the CCSDS Path Protocol Data Unit (Ver 1 source*
01.03.00.02.01.02		*Performance Requirement*	*The spacecraft shall support Grade 2 service (CCSDS Recommendations for Advanced Orbiting Systems, Networks and Datalinks: Architectural Specification)*
01.03.00.02.02	Data Rate	Functional Requirement	The data system shall support the required data rates for downlink data
01.03.00.02.03	Data Allocation	Functional Requirement	The C&DH subsystem shall accommodate throughput of data and telemetry from the instruments and subsystems during normal operation

Number/ Level	Requirement Title	Requirement Level	Requirement
01.03.00.02.03.01		*Performance Requirement*	*The C&DH subsystem shall be capable of accommodating a TES instrument data rate of 4900 kbps average and 6200 kbps peak*
01.03.00.02.03.02		*Performance Requirement*	*The C&DH subsystem shall be capable of accommodating a HIRDLS instrument data rate of 50 kbps average and 100 kbps peak*
01.03.00.02.03.03		*Performance Requirement*	*The C&DH subsystem shall be capable of accommodating a MLS instrument data rate of 120 kbps average and 120 kbps peak*
01.03.00.02.03.04		*Performance Requirement*	*The C&DH subsystem shall be capable of accommodating an ODUS instrument data rate of 50 kbps average and 100 kbps peak*
01.03.00.02.04	Downlink Encoding	Functional Requirement	The C&DH subsystem shall have various encoding options available to meet the spacecraft telemetry bit error rate (BER) (including Convolutional and Reed Solomon encoding)
01.03.00.02.04.01		*Performance Requirement*	*The C&DH subsystem shall have the capability to individually select or bypass the various downlink encoding options to allow configuration of the downlink to the various spacecraft telemetry modes*
01.03.00.03	**Data Bus**	Functional Category	The command and data handling among the observatory components shall be accomplished via a data bus
01.03.00.03.01	Bus Requirements	Functional Requirement	The C&DH shall utilize dual redundant data buses for distribution of commands and data to, and collection of engineering telemetry and science data from the instruments
01.03.00.03.01.01		*Performance Requirement*	*The spacecraft data bus shall accommodate a dual standby redundant data bus from resident instrument(s) for command and telemetry that fully complies with the requirements of MIL-STD-1553B,*
01.03.00.03.02	Bus Diagnostic Support	Functional Requirement	The spacecraft shall be capable of receiving commands with imbedded diagnostics, placing these diagnostics on the data bus to selected remote terminals, collecting data from the remote terminals, and sending the data to the ground
01.03.00.04	**Timing**	Functional Category	The data system shall provide the high precision frequency source for the onboard time generation and update for the observatory
01.03.00.04.01	Time Mark and Time Code Interface	Functional Requirement	The C&DH subsystem shall generate a timing signal for use as the synchronizing signal for the subsystems and instruments on the spacecraft
01.03.00.04.01.01		*Performance Requirement*	*The spacecraft shall include a timing system that will allow time-tagging science events onboard to an accuracy of 10 milliseconds relative to International Atomic Time (TAI)*
01.03.00.04.01.02		*Performance Requirement*	*The format of spacecraft time code data sent to the ground shall comply with the recommendations in "CCSDS Recommendations for Time Code Formats"*
01.03.00.04.01.03		*Performance Requirement*	*The spacecraft shall be capable of accommodating changes to clock time and clock drift rates by ground command without disrupting instrument science data collection (the time-tag on science data packet will*
01.03.00.04.01.04		*Performance Requirement*	*Distribution of time mark and time code to the instruments shall meet the requirements of the GIRD*

Number/ Level	Requirement Title	Requirement Level	Requirement
01.03.00.05	**Data Storage**	Functional Category	The C&DH subsystem shall provide onboard storage space to store instrument science data and the spacecraft housekeeping data for high speed playback during ground contact
01.03.00.05.01	Storage Device Requirement	Functional Requirement	A data storage device shall be provided
01.03.00.05.01.01		*Performance Requirement*	*The C&DH subsystem shall be capable of storing (onboard) all science and engineering data generated over a minimum of 2 orbits*
01.03.00.05.01.02		*Performance Requirement*	*The C&DH subsystem shall be capable of simultaneous storing and retrieving telemetry and data to/from the storage device*
01.03.00.05.01.03		*Performance Requirement*	*The C&DH subsystem shall be capable of detecting and correcting single bit errors in the storage device*
01.03.00.05.02	Modes of Operation	Functional Requirement	The storage device shall have predetermined modes of operation during periods of ground contact unavailability

Number/ Level	Requirement Title	Requirement Level	Requirement
01.04	**Comm**	Subsystem	The communications subsystem shall provide communication between the spacecraft and NASA satellite communication elements
01.04.00.01	**NASA Comm System Interface**	Functional Category	The communication subsystem shall be compatible with the NASA communication network elements
01.04.00.01.01	EOS Ground Segment	Functional Requirement	The communication subsystem shall be compatible with the EOS ground segment documented in the "ESDIS Project Level II requirements"
01.04.00.02	**Forward (Receiver) Link**	Functional Requirement	The communication subsystem shall provide for communication reception during all modes of operation
01.04.00.02.01	EOS Ground Station Uplink	Functional Requirement	The receiver shall be compatible with the NASA EOS Ground Stations for commanding and range/Doppler tracking
01.04.00.02.01.01		*Performance Requirement*	*The communication subsystem shall have the capability to do commanding and ranging simultaneously*
01.04.00.02.01.02		*Performance Requirement*	*The spacecraft shall provide low gain antenna(s) which produce spherical coverage*
01.04.00.02.02	Emergency Uplink	Functional Requirement	The spacecraft shall be compatible with an alternative ground to space communication service for emergency commanding and tracking services (e.g. TDRSS, STDN, etc.)
01.04.00.02.03	Forward Link Margin	Functional Requirement	The communication subsystem shall provide a 3 dB margin when calculating the forward link budget
01.04.00.02.04	Uplink BER	Functional Requirement	The BER for the ground to spacecraft communication link shall be 10-5 or better
01.04.00.03	**Return (Transmitter) Link**	Functional Requirement	The communication subsystem shall provide for communication transmission during all modes of operation
01.04.00.03.01	EOS Ground Station Downlink	Functional Requirement	The communication subsystem shall be compatible with the NASA EOS Ground Stations for transmission of all science and engineering data
01.04.00.03.01.01		*Performance Requirement*	*The spacecraft shall be capable of direct data transmission of stored and real-time data to the ground via the S-band and/or X-band*
01.04.00.03.01.02		*Performance Requirement*	*The spacecraft shall be capable of transmitting engineering data in real time to EOS ground stations when stored data is not being transmitted*

Number/ Level	Requirement Title	Requirement Level	Requirement
01.04.00.03.01.03		*Performance Requirement*	*The spacecraft shall be capable of direct transmission of all science and engineering data in real time to the EOS ground stations (Fairbanks, Alaska [64.97°N, 147.52°W] and Spitsbergen, Norway [78.22°N,*
01.04.00.03.01.04		*Performance Requirement*	*A minimum of 3 dB implementation loss shall be included in the communications link design to account for losses associated with signal processing implementation such as demodulation loss*
01.04.00.03.01.05		*Performance Requirement*	*Adequate margin shall be included in the link design for rain induced attenuation and noise temperature increase to achieve 95% availability at a 5° elevation angle*
01.04.00.03.02	Emergency Downlink	Functional Requirement	The spacecraft shall be compatible with an alternative space to ground communication service for emergency communication and tracking services (e.g. TDRSS, STDN, etc.)
01.04.00.03.02.01		*Performance Requirement*	*Emergency downlink must be capable of being coherent with the uplink for tracking and time determination*
01.04.00.03.03	Return Link Margin	Functional Requirement	The communication subsystem shall provide a 3 dB margin when calculating the return link budget
01.04.00.03.04	Telemetry BER/ Correction	Functional Requirement	The spacecraft shall use various encoding schemes for the different telemetry modes (including convolutional and Reed Solomon encoding)
01.04.00.03.04.01		*Performance Requirement*	The BER for the spacecraft to ground communication link shall be 10-5 or better

Number/ Level	Requirement Title	Requirement Level	Requirement
01.05	**ACS**	Subsystem	The ACS shall be responsible for providing the necessary attitude control capability during all phases of the mission, including separation, earth acquisition, stabilization, orbit maneuvers, attitude maneuvers, calibration maneuvers, and slews
01.05.00.01	**Attitude**	Functional Category	The ACS shall provide the means for insuring the proper attitude of the observatory
01.05.00.01.01	Coordinate System	Functional Requirement	The ACS shall utilize an orthogonal, body fixed coordinate system
01.05.00.01.01.01		*Performance Requirement*	*The spacecraft shall use a right-hand, orthogonal, body-fixed XYZ coordinate system with the Z axis through the center of the earth (+Z toward earth), the of the spacecraft velocity vector (+X toward direction*
01.05.00.01.02	Attitude Control	Functional Requirement	The ACS shall provide 3 Axis stabilization and nadir pointing
01.05.00.01.02.01		*Performance Requirement*	*The requirements shall be met for the worst case environmental and internal disturbances and structural flexibility effects, except during periodic orbit maintenance velocity change maneuvers, when*
01.05.00.01.02.02		*Performance Requirement*	*The accuracy of pointing control for the spacecraft at the TES instrument interface shall be 108 arcseconds for all axes*
01.05.00.01.02.03		*Performance Requirement*	*The accuracy of pointing control for the spacecraft at the HIRDLS instrument interface shall be 900 arcseconds for all axes*
01.05.00.01.02.04		*Performance Requirement*	*The accuracy of pointing control for the spacecraft at the MLS instrument interface(s) shall be 1800 arcseconds for the Y (pitch) axis, 180 arcseconds for the X (roll) axis, and 1800 arcseconds for the Z (yaw)*
01.05.00.01.02.05		*Performance Requirement*	*The accuracy of pointing control for the spacecraft at the ODUS instrument interface(s) shall be 1800 arcseconds for the Y (pitch) axis, 1800 arcseconds for the X (roll) axis, and 3600 arcseconds for the Z (yaw)*
01.05.00.01.03	Attitude Knowledge	Functional Requirement	The spacecraft shall provide attitude sensor data with sufficient accuracy, resolution, and continuity to allow ground based definitive attitude computation
01.05.00.01.03.01		*Performance Requirement*	*Spacecraft pointing knowledge at the TES instrument interface shall be 108 arcseconds for all axes*
01.05.00.01.03.02		*Performance Requirement*	*Spacecraft pointing knowledge at the HIRDLS instrument interface shall be 120 arcseconds for the Y (pitch) axis, 120 arcseconds for the X (roll) axis, and 180 arcseconds for the Z (yaw) axis*
01.05.00.01.03.03		*Performance Requirement*	*Spacecraft pointing knowledge at the MLS instrument interface shall be 1 arcsecond for the Y (pitch) axis, 1 arcsecond for the X (roll) axis, and 10 arcseconds for the Z (yaw) axis (MLS pointing*
01.05.00.01.03.04		*Performance Requirement*	*Spacecraft pointing knowledge at the ODUS instrument interface shall be 900 arcseconds for all axes*

Number/ Level	Requirement Title	Requirement Level	Requirement
01.05.00.01.04	Attitude Stability/ Jitter	Functional Requirement	The spacecraft shall provide stability at the instrument interface
01.05.00.01.04.01		*Performance Requirement*	*Spacecraft pointing stability at the TES instrument interface shall be 36 arcseconds over1 second (long-term stability) and TBD (short-term stability)*
01.05.00.01.04.02		*Performance Requirement*	*Spacecraft pointing stability at the HIRDLS instrument interface shall be in accordance with the HIRDLS EID (HIRDLS Instrument External Interface Description, SP-HIR-14G)*
01.05.00.01.04.03		*Performance Requirement*	*Spacecraft pointing stability at the MLS instrument interface shall be TBD (long-term stability) and 50 arcseconds roll/pitch and 1800 arcseconds yaw over a range of 0.1 to 30 seconds (short-term stability)*
01.05.00.01.04.04		*Performance Requirement*	*Spacecraft pointing stability at the ODUS instrument interface shall be TBD (long-term stability) and 360 arcseconds over 200 milliseconds (short-term stability)*
01.05.00.02	**Orbit**	Functional Category	The ACS shall maintain required mission orbital parameters and position knowledge
01.05.00.02.01	Baseline Orbital Elements	Functional Requirement	The ACS shall maintain mission orbital element values within tolerances
01.05.00.02.01.01		*Performance Requirement*	*The ACS shall maintain the following orbital elements: nominal orbit altitude 705 km, ascending node time 1:45 ± 15 min, ground track repeatability 20 km (3 sigma, all latitudes, cross track), repeat cycle 233 revolutions (16 days)*
01.05.00.02.02	Position Knowledge	Functional Requirement	The position of the observatory, when in the mission orbit, shall be determined autonomously (GPS) or through ephemeris uplink
01.05.00.02.02.01		*Performance Requirement*	*The ACS shall perform ephemeris propagation*
01.05.00.02.02.02		*Performance Requirement*	*As a minimum for backup, the spacecraft shall have the capability of receiving predicted orbit data every 24 hours (in a prespecified format) with an accuracy of 500 meters (3 sigma) at the end of the 24 hour*
01.05.00.02.02.03		*Performance Requirement*	*The spacecraft shall provide attitude and orbit parameters computed onboard to the ground*
01.05.00.03	**ACS Control Modes**	Functional Category	The ACS shall provide the necessary modes required to control the attitude and position to the observatory
01.05.00.03.01	Safe Mode	Functional Requirement	Entry into the safe mode shall be ground commandable as well as automatic upon detection of pre-defined anomalous conditions
01.05.00.04	**Attitude Maneuvering**	Functional Category	The observatory shall provide the command/signal processing necessary for attitude maneuvering
01.05.00.04.01	MLS Scanning	Functional Requirement	The satellite upon which the MLS instrument resides shall have the capability of nodding the MLS instrument about the Y axis of the spacecraft (i.e., performing the MLS scan function)

Number/ Level	Requirement Title	Requirement Level	Requirement
01.05.00.04.01.01		*Performance Requirement*	*The MLS scan profile requires a 0.93° top-to-bottom translation in 12.2 sec with motion reversal in 4.1 sec followed by a 0.93° bottom-to-top translation in 12.2 sec with motion reversal 4.1 sec (32.6 sec/cycle),*
01.05.00.04.02	Pitch/Roll Offset Pointing	Functional Requirement	The spacecraft shall have the capability of pitch and/or roll offset pointing up to 5° beyond the earth disk and maintaining the pointing for up to a complete orbit
01.05.00.05	**Solar Array Pointing**	Functional Category	The ACS shall control the pointing of the solar array(s)
01.05.00.05.01	Pointing Control	Functional Requirement	The ACS shall provide the commands necessary for pointing of the solar array(s)

Number/ Level	Requirement Title	Requirement Level	Requirement
01.06	**Propulsion**	Subsystem	The Propulsion Subsystem shall provide the impulse(s) for altitude/ attitude control and maintenance required by the observatory to meet mission objectives
01.06.00.01	**Attitude/ Velocity Control**	Functional Category	The Propulsion Subsystem shall provide the impulse(s) required for tip-off rate nulling, initial orbit insertion, altitude maintenance, attitude control (backup/momentum wheel unloading), and end of life disposal
01.06.00.01.01	Mission Orbit Acquisition	Functional Requirement	The Propulsion Subsystem shall be capable of nulling ELV-induced tip-off rates and providing impulse necessary to acquire mission altitude and inclination specified section 01.05.00.02 (Orbit)
01.06.00.01.02	Drag Makeup ($\bar{V}$)	Functional Requirement	The Propulsion Subsystem shall be capable of maintaining the orbit parameters within tolerances in the presence of the atmospheric drag and solar flux
01.06.00.01.03	Momentum Unloading	Functional Requirement	The Propulsion Subsystem shall provide momentum unloading
01.06.00.01.04	Disposal	Functional Requirement	The Propulsion Subsystem shall provide end-of-life disposal through either reboosting the spacecraft to a higher orbit (perigee > 2,500 km and apogee > 35,288 km) or lowering (deboost) the spacecraft such that atmospheric re-entry occurs within 25 years
01.06.00.01.05	Propellant Requirements	Functional Requirement	The Propulsion Subsystem shall provide sufficient propellant to meet tipoff, orbit acquisition, drag makeup (7.5 years), momentum unloading, and reboost/deorbit burn requirements

Number/ Level	Requirement Title	Requirement Level	Requirement
01.07	**TCS**	Subsystem	The Thermal Control Subsystem shall provide thermally acceptable environments for the spacecraft components and science experiments in all phases of the mission
01.07.00.01	**Temperature Limits**	Functional Category	The Thermal Control Subsystem design shall maintain all spacecraft bus subsystems and components, and instrument interfaces at specified temperature levels, thermal gradients, and temperature transition rates
01.07.00.01.01	Survival Temperature Limits	Functional Requirement	The TCS shall maintain the temperatures of all component and instrument mounting interfaces within the survival ranges (with adequate margin) at all times
01.07.00.01.02	Operating Temperature Limits	Functional Requirement	During normal operations, and with all instruments powered, the TCS shall maintain the temperatures of all component and instrument mounting interfaces within their operating ranges (with adequate margin)
01.07.00.01.03	Thermal Constraints	Functional Requirement	Subsystems/components shall be thermally safe during worst case thermal conditions (e.g., non-operation or Safe Hold)
01.07.00.02	**Thermal Hardware**	Functional Category	The thermal control subsystem may implement both active (e.g., heaters/controllers, louvers) and passive (e.g., blankets, radiators) thermal control hardware
01.07.00.03	**Signal Processing**	Functional Category	The thermal control subsystem shall provide subsystem/component thermal telemetry
01.07.00.03.01	Temperature Monitoring	Functional Requirement	The thermal subsystem shall collect a sufficient number of temperature data points to monitor performance of the thermal subsystem
01.07.00.04	**Instrument Thermal Interface**	Functional Category	The instrument thermal interface shall be designed such that all spacecraft and instrument thermal requirements are satisfied (As a goal, the instrument thermal interface shall minimize the heat exchange between the
01.07.00.04.01	Conductive Interface	Functional Requirement	The instrument mounting thermal interface to the spacecraft shall control the interface conductive heat transfer such that all spacecraft and instrument thermal requirements are satisfied
01.07.00.04.02	Radiative Interface	Functional Requirement	The instrument thermal radiative interface to the spacecraft shall control the interface radiative heat transfer such that all spacecraft and instrument thermal requirements are satisfied

Number/ Level	Requirement Title	Requirement Level	Requirement
01.08	**Structure**	Subsystem	The structural subsystem shall provide structural support to the spacecraft components and instruments from ground testing to mission operation
01.08.00.01	**Design**	Functional Category	The spacecraft shall be designed to withstand all specified environments without deformation, including buckling and yielding
01.08.00.01.01	Structural Integrity	Functional Requirement	The spacecraft structure shall be of sufficient strength and stiffness to maintain structural integrity and withstand all ground testing, handling, transportation, launch and mission orbit environments with margins of safety
01.08.00.01.01.01		*Performance Requirement*	*The NASA Structural Analysis (NASTRAN) program and detailed hand stress analysis shall be used for analyzing the structure design*
01.08.00.01.02	Alignment	Functional Requirement	The structure subsystem shall support the observatory alignment requirements
01.08.00.01.02.01		*Performance Requirement*	*The spacecraft structure shall provide an alignment reference to align the instruments to the ACS axes*
01.08.00.01.03	Spacecraft Access	Functional Requirement	The spacecraft design shall be such that removal and/or maintenance of a specific separately mounted instrument can be accomplished without removal of other separately mounted instruments (e.g., HIRDLS/ODUS)
01.08.00.01.04	Structure Requirements	Functional Requirement	The spacecraft structure shall accommodate mounting of all instruments and subsystem components as detailed in the GIRD, UIIDs, IDDs, and instrument presentations
01.08.00.01.04.01		*Performance Requirement*	*No part of any operating instrument, subsystem or component shall interfere with the proper operation of any other instrument, subsystem or component*
01.08.00.01.05	Mechanism Support	Functional Requirement	The structure shall provide the necessary FOV, and clearance for the spacecraft subsystems
01.08.00.01.05.01		*Performance Requirement*	*The structural design shall meet the envelope requirements for solar array and antenna deployment, articulation, and Field-Of-View*
01.08.00.01.06	Instrument Requirements	Functional Requirement	The structure shall provide the necessary thermal FOV(s), science FOV(s), and clearance for the instruments
01.08.00.02	**Launch Vehicle Constrai**	Functional Category	The mechanical subsystem shall accommodate the launch vehicle constraints for the selected launch vehicle (Med Lite family of launch
01.08.00.02.01	Mechanical Interface	Functional Requirement	Spacecraft structure shall provide a mechanical interface to the launch vehicle (payload attach fitting)
01.08.00.02.02	Launch Volume	Functional Requirement	The volume of the observatory shall meet the selected launch vehicle requirements (Med-Lite family of launch vehicles)
01.08.00.02.03	Mass Properties	Functional Requirement	Spacecraft weight and CG shall be compatible with selected launch vehicle capabilities

Number/ Level	Requirement Title	Requirement Level	Requirement
01.08.00.02.03.01		*Performance Requirement*	*The spacecraft shall allocate 363 kg (for the instrument payload) when accommodating the TES instrument*
01.08.00.02.03.02		*Performance Requirement*	*The spacecraft shall allocate 163 kg (for the instrument payload) when accommodating the HIRDLS instrument*
01.08.00.02.03.03		*Performance Requirement*	*The spacecraft shall allocate 375 kg (for the instrument payload) when accommodating the MLS instrument*
01.08.00.02.03.04		*Performance Requirement*	*The spacecraft shall allocate 50 kg (for the instrument payload) when accommodating the ODUS instrument*
01.08.00.02.04	Environmental Loads	Functional Requirement	The observatory shall withstand all environmental conditions imposed by the selected launch vehicle
01.08.00.02.04.01		*Performance Requirement*	*The spacecraft structure shall be capable of sustaining the launch, ascent and deployment environments*

Number/ Level	Requirement Title	Requirement Level	Requirement
01.09	**Software**	Subsystem	The C&DH subsystem software shall control command/telemetry data processing
01.09.00.01	**Flight Software Design**	Functional Category	The spacecraft flight software design shall be flexible and reconfigurable for ease of operations
01.09.00.01.01	Software Flexibility	Functional Requirement	Flight software design shall be rigid in terms of scheduling and setting priorities for certain critical processing tasks to assure their completion on time
01.09.00.01.02	Software Tasks	Functional Requirement	The flight software design shall accommodate processing of ground commands, revisions (on orbit) to the spacecraft telemetry format definition, computer self checks, redundancy management, and spacecraft mode
01.09.00.01.03	Event Logging/ Time Tagging	Functional Requirement	The flight software design shall include software event logging in telemetry which logs and time-tags all anomalous events and system performance events
01.09.00.02	**Processor Management and**	Functional Category	Certain minimum software management and control functions shall performed by the processor
01.09.00.02.01	Throughput Margin	Functional Requirement	The spacecraft shall demonstrate a processor throughput margin for software development/growth and on-orbit contingencies
01.09.00.02.01.01		*Performance Requirement*	*The spacecraft shall demonstrate a processor throughput margin of 25% for a mature design or a 50% throughput margin for a new design*
01.09.00.02.02	Automatic Command Sequences	Functional Requirement	The spacecraft shall support automatic execution of pre-planned command sequences to perform emergency reconfiguration upon the sensing of pre-defined anomalous conditions in engineering data
01.09.00.02.03	Software Revisions	Functional Requirement	The hardware/software design of the spacecraft shall be capable of implementing uplinked software revisions/corrections to spacecraft processor(s) and providing this support to instrument processors
01.09.00.02.04	RAM Loading/ Dumping	Functional Requirement	The loading/dumping of processor RAM and the initiation of all or part of the software tasks shall be available upon processor reset, either through PROM Bootstrap code or hardware commands
01.09.00.02.05	Memory Upload	Functional Requirement	In the event a complete onboard processor memory upload is required while the spacecraft is in Safe Mode, the software shall be capable of being loaded in segments and shall be usable prior to completion of the entire
01.09.00.03	**Software Development and Validation Facility**	Functional Category	A well documented flight software, and flight software development environment that accurately simulates the onboard spacecraft environment shall be provided for software development, modification, and maintenance

Number/ Level	Requirement Title	Requirement Level	Requirement

Unassigned Spacecraft Requirements

	Design, Fabrication, Integration, and		The design, fabrication, integration and verification of the spacecraft shall comply with all the requirements in the Earth Observing System PAR
	Orbital Debris Generation		The spacecraft shall be designed to minimize the potential for orbital debris generation in both nominal operation and malfunction conditions
	Contamination		The spacecraft shall be designed to prevent degradation of performance due to contamination for all phases of the mission including instrument layout, integration, test, ground handling, storage and transportation
	Contamination		Degradation of contamination-sensitive hardware due to contamination on ground and during all mission phases shall not be to such a degree as to prevent the hardware from meeting mission requirements during the 6-year on-orbit design lifetime
	Fault Tolerance		No single failure in the spacecraft bus, instrument-to-spacecraft interface, and/or single ground operator error, shall permanently preclude the spacecraft from supporting the mission science
	Fault Tolerance		A failure in one component or subsystem shall not induce failures in other parts of the spacecraft
	Fault Recovery		The spacecraft design shall support detection, isolation, and recovery capabilities for any single fault in the spacecraft bus to ensure the health and safety of the spacecraft
	Fault Recovery		The spacecraft shall be capable of surviving the occurrence of any single failure in the spacecraft bus or loss of contact with the ground for a minimum of 24 hours
	Natural and Induced Environments		The spacecraft shall be designed to meet all performance requirements during and after exposure to both natural and induced environments throughout operation in orbit, with the following exception: science data collection is not required during ΔV man
	Component Lifetime Data		Projected life requirements shall be supported with data and/or analysis
	Radiation Hardening		The spacecraft shall be capable of meeting all performance requirements in the 5-year total ionizing dose environments specified in the GIRD
	Single Event Upset		The spacecraft shall be capable of meeting all performance requirements in the Cosmic Ray and High Energy Proton Radiation Environment specified in the GIRD

Number/ Level	Requirement Title	Requirement Level	Requirement
			Spacecraft I&T Requirements
	External Fast Load and Dump of Processor		During Integration and Test, selected processors (bus and instrument) shall be capable of fast memory loads and dumps at any time prior to launch via an interface that is in addition to the on-orbit command link.
	External Fast Load and Dump of Processor		Fast memory loads of selected processor (bus and instrument) during integration and test shall take no longer than 15 minutes.
	Instrument Integration		The spacecraft design shall accommodate integration of the instruments onto the spacecraft bus in any order of instrument delivery.
	Spacecraft/ Instrument Interface Simulator		The spacecraft instrument interface simulator shall simulate all functions of the spacecraft power, electrical, command and data handling systems in sufficient detail to allow the instrument to verify its interface before delivery to the spacecraft
	Spacecraft/ Instrument Interface Simulator		The interface simulator shall comply with the interface requirements of the "General Interface Requirements Document (GIRD) for EOS Spacecraft/Instruments".
	Electrical Ground Support Equipment (EGSE)		The instrument EGSE shall interface with the spacecraft EGSE via a local area network (ethernet or other interface) and/or point-to-point links (if necessary) which supports the exchange of telemetry, time, commands, command status, CSTOL procedures and
	Electrical Ground Support Equipment (EGSE) Interface		The instrument EGSE shall receive near real-time instrument telemetry via the spacecraft EGSE.
	Electrical Ground Support Equipment (EGSE) Interface		Commanding of the instruments as well as the spacecraft bus shall be from the spacecraft EGSE.
	Mechanical Ground Support Equipment (MGSE)		The spacecraft shall accommodate MGSE hard point interfaces for operations such as lifting, rotating and transporting.